

USE OF PLASMA REACTION DEVICE

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Inventor: FUJIWARA NOBUO

Applicant: MITSUBISHI ELECTRIC CORP

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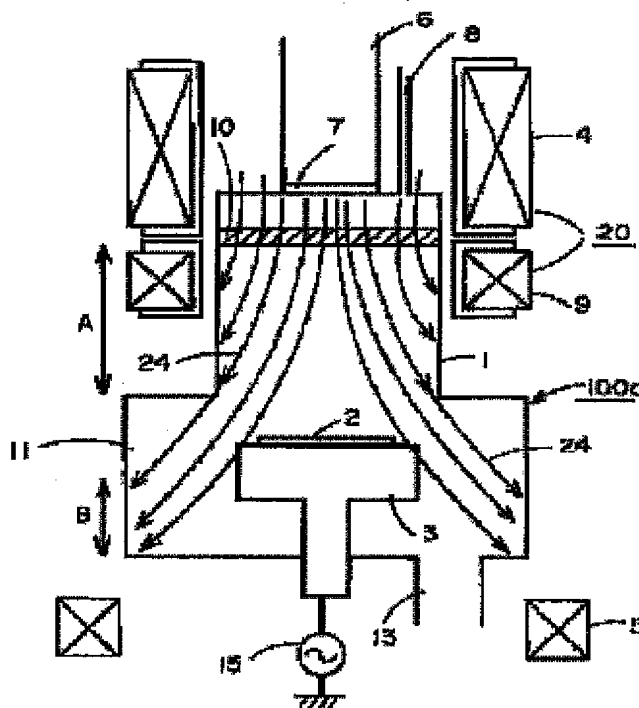
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Abstract of JP6208971

PURPOSE: To provide a way of using a plasma reaction device by which high etching anisotropy is obtained. **CONSTITUTION:** Relating to a plasma device provided with a plasma generation chamber and the reaction chamber connected to it, a to-be-processed material is etched, while the material is supplied with high frequency electric power, under the condition in which the plasma loss amount at an inner wall A in the plasma generation chamber 1 is set to one and a half times that at an inner wall B in the reaction chamber 11 or times.



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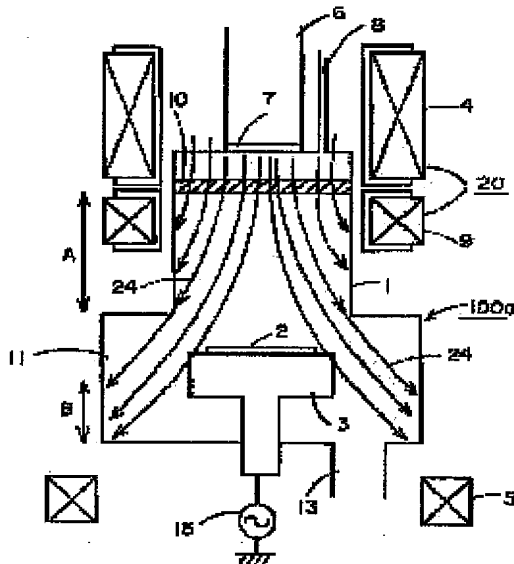
(72)Inventor : FUJIWARA NOBUO

(54) USE OF PLASMA REACTION DEVICE

(57)Abstract:

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CONSTITUTION: Relating to a plasma device provided with a plasma generation chamber and the reaction chamber connected to it, a to-be-processed material is etched, while the material is supplied with high frequency electric power, under the condition in which the plasma loss amount at an inner wall A in the plasma generation chamber 1 is set to one and a half times that at an inner wall B in the reaction chamber 11 or times.



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1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. *** shows the word which can not be translated.
3. In the drawings, any words are not translated.

CLAIMS**[Claim(s)]**

[Claim 1] A plasma production room and the waveguide which introduces microwave into said plasma production room, It has the reaction chamber connected with the magnetic field generating means formed in the periphery of said plasma production room at said plasma production room. By said microwave and the magnetic field by said magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the operation of the plasma reactor which carries out anisotropic etching of said processed material by said plasma while supplying high-frequency power to the processed material which led said plasma to said reaction chamber, and was installed in said reaction chamber. Operation of the plasma reactor characterized by the amount of plasma loss in said plasma production room wall making it possible to acquire the high anisotropy stabilized in said anisotropic etching by [of 1.5 times or more of the amount of plasma loss in said reaction chamber wall] setting up so that it may become.

[Claim 2] A plasma production room and the waveguide which introduces microwave into said plasma production room, It has the reaction chamber connected with the magnetic field generating means formed in the periphery of said plasma production room at said plasma production room. By said microwave and the magnetic field by said magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the operation of the plasma reactor which carries out anisotropic etching of the processed material which drew said plasma in said reaction chamber, and was installed in said reaction chamber. By setting up so that the amount of plasma loss in said plasma production room wall may become 2 double less or equal of the amount of plasma loss in said reaction chamber wall Operation of the plasma reactor characterized by making it possible to acquire the high etch selectivity stabilized in said anisotropic etching, and an anisotropy.

DETAILED DESCRIPTION**[Detailed Description of the Invention]****[0001]**

[Industrial Application] This invention relates to improvement in the anisotropy in that anisotropic etching especially about the operation of a plasma reactor which performs anisotropic etching of processed material, such as a semi-conductor substrate, using the plasma generated by electron cyclotron resonance (ECR) discharge.

[0002]

[Description of the Prior Art] In manufacture of a semiconductor device, processing of formation of the thin film on a semi-conductor substrate, etching of a semi-conductor substrate, etc. is performed. There is a plasma reactor which used the plasma by the discharge in gases as one of the processors of such a semi-conductor substrate.

[0003] Drawing 4 is the rough sectional view of the conventional common plasma reactor using the plasma generated by ECR discharge. This plasma reactor 100 contains the mirror coil 5 further with the quartz plate 7 used as the plasma production room 1, the waveguide 6 for introducing microwave all over that plasma production room 1, and the inlet of the microwave into the plasma production room 1, and the single solenoid coil 4 and single auxiliary coil 9 which act as a magnetic field generating means 20 established so that the periphery of the plasma production room 1 might be surrounded. The pars basilaris ossis occipitalis of the plasma production room 1 is united with the upper part of a reaction chamber 11. The maintenance base 3 for carrying the processed material 2, such as a semi-conductor substrate, is established in the interior of a reaction chamber 11. Furthermore, the gas installation tubing 8 is connected to the upper part of the plasma production room 1, and the exhaust port 13 is established in the pars basilaris ossis occipitalis of a reaction chamber 11.

[0004] Thus, in use of the constituted plasma reactor 100, the interior of a reaction chamber 11 and the plasma production room 1 is fully exhausted by the vacuum pump (not shown) through an exhaust port 13. After that,

introducing reactant gas into the plasma production room 1 from the gas installation tubing 8, a part of the gas is exhausted from an exhaust port 13, and the gas pressure in the plasma production room 1 and a reaction chamber 11 is maintained by the predetermined value. Furthermore, microwave with a frequency of 2.45GHz generated according to the microwave power source (not shown) is introduced in the plasma production room 1 through a waveguide 6 and the quartz plate 7.

[0005] On the other hand, it energizes to the single solenoid coil 4 prepared in the periphery of the plasma production room 1, and the magnetic field for exciting ECR is generated. This magnetic field is set up so that it may have the field of the flux density of 875Gauss. At this time, it energizes so that an auxiliary coil 9 may also produce the field of the same direction as a solenoid coil 4, and it is set up so that the difference of the maximum of the field gradient in alignment with the shaft orientations in the ECR field 10 formed among both the coils 4 and 9 and the minimum value may become 10 or less Gauss/cm. Therefore, uniform plasma production is performed in the ECR field 10 whole which met in the direction of the cross section of the plasma production room 1.

[0006] Furthermore, it energizes so that the mirror coil 5 may also generate the field of the same direction as a solenoid coil 4, and a weak mirror magnetic field is formed between a solenoid coil 4 and the mirror coil 5, and line of magnetic force is made to act perpendicularly to the front face of the semi-conductor substrate 2 by it.

[0007] In the plasma reactor used as mentioned above, the reactant gas molecule in the plasma production room 1 is plasma-ized by the collision with the electron accelerated by ECR. The generated reactant gas plasma is diffused along with line of magnetic force, and carries out incidence at right angles to the front face of the semi-conductor substrate 2 on the maintenance base 3. At this time, the front face of the semi-conductor substrate 2 is etched with directivity, namely, anisotropic etching is realized. In addition, the class of reactant gas used in this case, a pressure, microwave power, etc. are chosen according to the class of process of the semi-conductor substrate 2 which should be processed.

[0008]

[Problem(s) to be Solved by the Invention] In use of conventional ECR plasma equipment, it was not taken into consideration at all about the setting location of the ECR field 10 in the plasma production room 1. Therefore, the etching property was changing depending on the case where the ECR field 10 is close to the microwave installation aperture 7, or the case of being close to a boundary with a reaction chamber 11. That is, depending on the setting location of the ECR field 10, sufficient anisotropy in etching was not acquired and the technical problem of sufficient bias voltage not being impressed to the semi-conductor substrate 2 occurred.

[0009] It is offering the operation of the plasma reactor which one purpose of this invention enables impression of the high bias voltage to processed material in view of the technical problem in such a conventional technique, and can enable stable etching which has a high anisotropy.

[0010] Another purpose of this invention is offering the operation of the plasma reactor which can enable etching of a high anisotropy by high etch selectivity, without impressing bias voltage to processed material.

[0011]

[Means for Solving the Problem] The operation of the plasma reactor by one mode of this invention A plasma production room and the waveguide which introduces microwave into the plasma production room, It has the reaction chamber connected with the magnetic field generating means formed in the periphery of a plasma production room at the plasma production room. By microwave and the magnetic field by the magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the operation of the plasma reactor which carries out anisotropic etching of the processed material by the plasma while supplying high-frequency power to the processed material which drew the plasma in the reaction chamber and was installed in the reaction chamber. By setting up so that the amount of plasma loss in a plasma production room wall may become 1.5 or more times of the amount of plasma loss in a reaction chamber wall, it makes it possible to acquire the high anisotropy stabilized in anisotropic etching.

[0012] The operation of the plasma reactor by another mode of this invention A plasma production room and the waveguide which introduces microwave into the plasma production room, It has the reaction chamber connected with the magnetic field generating means formed in the periphery of a plasma production room at the plasma production room. By microwave and the magnetic field by the magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the operation of the plasma reactor which carries out anisotropic etching of the processed material which drew the plasma in the reaction chamber and was installed in the reaction chamber by the plasma. By setting up so that the amount of plasma loss in a plasma production room wall may become 2 double less or equal of the amount of plasma loss in a reaction chamber wall, it makes

it possible to acquire the high etch selectivity stabilized in anisotropic etching, and an anisotropy.

[0013]

[Function] In the operation of the plasma reactor by one mode of this invention, since the amount of plasma loss in a plasma production room wall is set as 1.5 or more times of the amount of plasma loss in a reaction chamber wall, plasma potential is fixed in the processed material upper part. Therefore, since it has the operation whose bias voltage impressed to processed material draws ion, without changing plasma potential even if it supplies high-frequency power to processed material, it becomes possible to perform strong etching of an anisotropy.

[0014] another voice of this invention – in the operation of the plasma reactor twisted like, since it is set up so that the amount of plasma loss in a plasma production room wall may become 2 double less or equal of the amount of plasma loss in a reaction chamber wall, the flow of the processed material upper plasma is not disturbed. Therefore, by the plasma which carries out incidence with directivity into the reaction chamber in which processed material was installed, even if it does not impress bias voltage to processed material, etching of a high anisotropy may be performed. In this case, since the ion which carries out incidence has low energy compared with the case where bias voltage exists, etching which has the high selectivity depending on the quality of the material of processed material becomes possible at coincidence.

[0015]

[Example] Drawing 1 is the rough sectional view of the plasma reactor used in one example of this invention. The plasma reactor of drawing 1 is similar to the thing of drawing 4, and the same reference mark is given to the same part or the corresponding part. However, in plasma reactor 100a of drawing 1, the ECR field 10 brings close to the quartz plate 7 which is a microwave installation aperture, and is prepared. That is, in the plasma reactor of drawing 1, compared with the thing of drawing 4, a solenoid coil 4 and an auxiliary coil 9 move up, and are positioned. Furthermore, RF generator 15 is connected to the maintenance base 3, and it is possible to impress high frequency bias to the processed material 2, such as a semi-conductor substrate.

[0016] Of the magnetic field formed with a solenoid coil 4, line of magnetic force 24 has spread toward the reaction chamber 11 from the plasma production room 1, and the so-called emission magnetic field is formed. The plasma generated in the ECR field 10 is diffused along with line of magnetic force 24, and is extinguished in the part which line of magnetic force 24 and the walls A and B of a container intersect.

[0017] What is mainly committed as a counterelectrode when high-frequency power is supplied to the semi-conductor substrate 2 since the potential of the plasma is determined depending on the disappearing part is the field of the walls A or B which are the disappearance parts of the plasma. However, since the temperature and the consistency of the plasma which disappear by Walls A and B are mutually different, the potential of Walls A and B is a different value. That is, it is the value from which the potential of the plasma extinguished by each wall A and B also differed. Therefore, it is not easy to impress uniform bias voltage to the front face of the semi-conductor substrate 2.

[0018] Since the location of Wall B is in a part for the downstream of the side of the maintenance base 3, or a plasma style when Wall B serves as main counterelectrodes of high frequency bias especially, bias voltage must have been impressed to the front face of the semi-conductor substrate 2.

[0019] However, in the example of drawing 1, since magnetic field arrangement in which the ECR field 10 is formed near the quartz substrate 7 is used, the area of the wall A to which the plasma is extinguished in the upper plasma production room 1 of the semi-conductor substrate 2 is larger than the area of the wall B to which the plasma is extinguished in a reaction chamber 11. Therefore, it becomes Wall A to work as main counterelectrodes of the semi-conductor substrate 2 in impression of high frequency bias voltage, and it can impress bias voltage to the semi-conductor substrate 2 uniformly and certainly moreover by it. Consequently, since bias voltage draws plasma ion in the direction perpendicular to the front face of the semi-conductor substrate 2, it becomes possible to perform strong etching of an anisotropy.

[0020] Drawing 2 is a graph which surface ratio A/B of Walls A and B is changed, and shows change of the etching property at the time of ****. In this graph, an axis of abscissa expresses the surface ratio of Walls A and B, and a left-hand side axis of ordinate expresses the degree of an etching anisotropy, and the right-hand side axis of ordinate expresses the selection ratio of etching depending on the quality of the material of processed material. - The curve expressed with the mark expresses an etching anisotropy, it is expressed with x mark, and the curve expresses the selection ratio of etching. The surface ratio of Walls A and B changes by moving coils 4 and 9, and is *****. moreover, the selection ratio of etching -- Si/SiO₂ ***** -- it asked. The degree of an etching anisotropy is shown as a ratio of the etching depth at the time of etching Si by using a resist pattern as a mask, and the

amount of side etch. Furthermore, high frequency bias power had the frequency of 13.56MHz, and the power was 50W.

[0021] It turns out that the anisotropy of etching is improving as surface ratio A/B of Walls A and B becomes large so that clearly from drawing 2. Moreover, Si and SiO₂ It can check that etch selectivity is falling as surface ratio A/B becomes large, the bias effectiveness will become remarkable if surface ratio A/B is raised, and the incidence energy of plasma ion is increasing.

[0022] If the anisotropy of etching is improving and it puts in another way as a conclusion when surface ratio A/B is 1.5 or more, when the amount of plasma loss in the wall A of the plasma production room 1 is 1.5 or more times of the amount of plasma loss in the wall B of a reaction chamber 11, the etching anisotropy will improve.

[0023] Drawing 3 expresses the effect of surface ratio A/B of the walls A and B in another example of this invention. Although the graph of drawing 3 is similar to the thing of drawing 2, in the graph of drawing 3, high frequency bias voltage is not impressed to the semi-conductor substrate 2. In this case, it turns out that the anisotropy of etching is increasing as surface ratio A/B becomes small. If disappearance of the plasma in Wall B becomes dominant, since this will serve as a uniform plasma style which goes to a reaction chamber 11 from an ECR field, it originates in plasma ion carrying out incidence to a semi-conductor substrate front face with directivity. If surface ratio A/B becomes large, since disappearance of the plasma in Wall A will become dominant, it does not become the uniform amount of plasma which goes in the reaction chamber 11 direction, but will be in the condition that the plasma exists in turbulent flow in the plasma production room 1. Therefore, the anisotropy of etching will become low if surface ratio A/B becomes large.

[0024] That is, if the anisotropy of etching is improving and it puts in another way when surface ratio A/B is 2.0 or less, when the amount of plasma loss in the wall A of the plasma production room 1 is 2.0 or less times of the amount of plasma loss in the wall B of a reaction chamber 11, the etching anisotropy will improve.

[0025] On the other hand, since high frequency bias voltage is not impressed to the semi-conductor substrate 2 in this example, it turns out that the selection ratio (Si/SiO₂) of etching which a plasma style has low energy, therefore was dependent on the quality of the material of processed material is in high level.

[0026] In addition, although control of the amount of plasma loss was performed by moving a solenoid coil 4 and an auxiliary coil 9 in the above example, the same effectiveness is acquired even if it uses change of the magnetic field distribution by preparing two or more coils and changing the exciting current of each coil.

[0027]

[Effect of the Invention] as mentioned above, one voice of this invention – in the operation of the plasma reactor twisted like, since high frequency bias voltage is impressed to processed material and the amount of plasma loss in a plasma production room wall is made into 1.5 or more times of the amount of plasma loss in a reaction chamber wall, the high-frequency power to processed material can be efficiently impressed by homogeneity, and strong etching of an anisotropy may be realized.

[0028] another voice of this invention – in the operation of the plasma reactor twisted like, since the amount of plasma loss in a plasma production room wall is made into 2 double less or equal of the amount of plasma loss in a reaction chamber wall, without impressing high frequency bias power to processed material, it is possible to raise the etching anisotropy of processed material, and etching which has the high selection ratio which is dependent on the quality of the material of processed material with the plasma ion of low energy is attained.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is a sectional view for explaining the operation of the plasma reactor by one example of this invention.

[Drawing 2] It is the graph which shows whenever [surface ratio A/B / of the wall of a plasma production room and the wall of a reaction chamber in the condition that bias voltage was impressed to processed material /, and etching anisotropy], and, the interrelation in the selection ratio of etching.

[Drawing 3] They are whenever [surface ratio A/B / of the wall of a plasma production room and the wall of a reaction chamber in the condition that bias voltage is not impressed to processed material /, and etching anisotropy], and, the graph which shows the interrelation of etch selectivity.

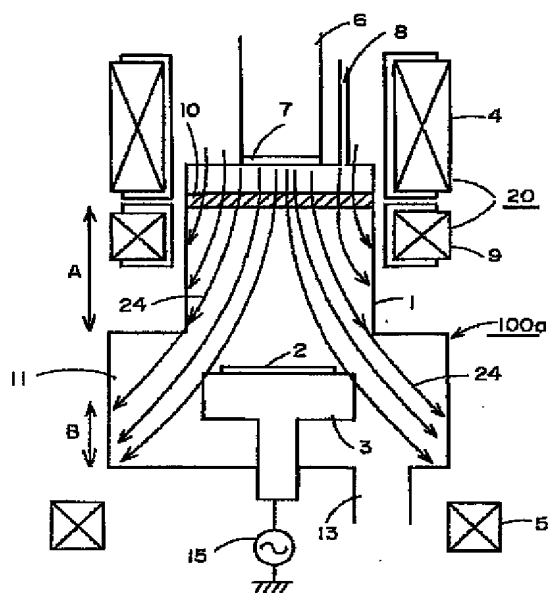
[Drawing 4] It is the rough sectional view showing the conventional plasma reactor.

[Description of Notations]

1 Plasma Production Room
2 Processed Material
3 Susceptor
4 Solenoid Coil
5 Mirror Coil
6 Waveguide
7 Quartz Plate
8 Gas Installation Tubing
9 Auxiliary Coil
10 ECR Field
11 Reaction Chamber
13 Exhaust Port
15 RF Generator
20 Magnetic Field Generating Means
24 Line of Magnetic Force
100a Plasma reactor

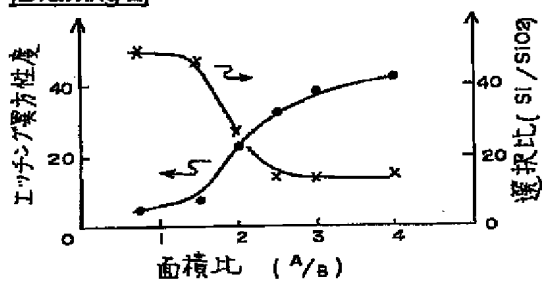
DRAWINGS

[Drawing 1]

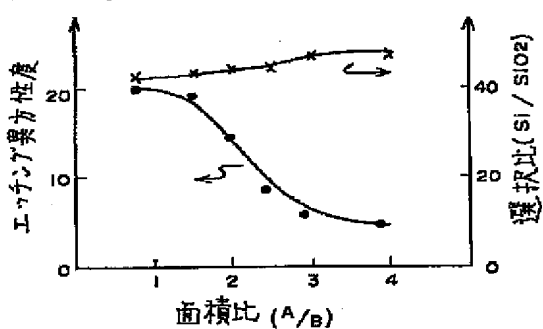


- | | |
|-------------|----------------|
| 1: プラズマ生成室 | 8: ガス導入管 |
| 2: 被処理材 | 9: 補助コイル |
| 3: 支持台 | 10: ECR領域 |
| 4: ソレノイドコイル | 13: 排気口 |
| 5: ミラーコイル | 15: 高周波電源 |
| 6: 導波管 | 20: 磁場発生手段 |
| 7: 石英板 | 24: 磁力線 |
| | 100a: プラズマ反応装置 |

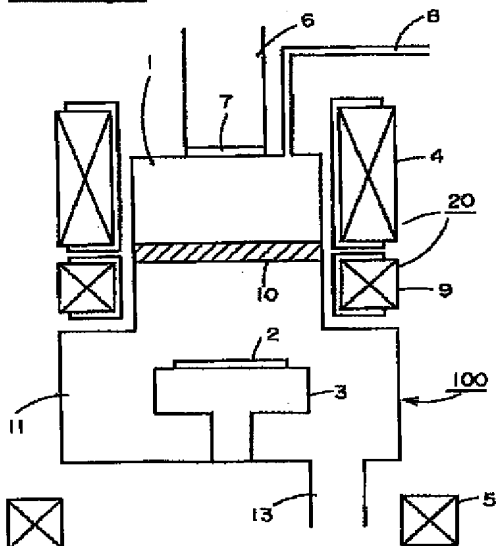
[Drawing 2]



[Drawing 3]



[Drawing 4]



CORRECTION OR AMENDMENT

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[Procedure amendment 1]

[Document to be Amended] Specification

[Item(s) to be Amended] The name of invention

[Method of Amendment] Modification

[Proposed Amendment]

[Title of the Invention] The operation of a plasma reactor, and the plasma treatment approach of a substrate

[Procedure amendment 2]

[Document to be Amended] Specification

[Item(s) to be Amended] Claim

[Method of Amendment] Modification

[Proposed Amendment]

[Claim(s)]

[Claim 1] A plasma production room and the waveguide which introduces microwave into said plasma production room, It has the reaction chamber connected with the magnetic field generating means formed in the periphery of said plasma production room at said plasma production room. By said microwave and the magnetic field by said magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the operation of the plasma reactor which carries out anisotropic etching of said processed material by said plasma, supplying high-frequency power to the processed material which led said plasma to said reaction chamber, and was installed in said reaction chamber,

Operation of the plasma reactor characterized by making it possible to acquire the high anisotropy stabilized in said anisotropic etching by setting up so that the amount of plasma loss in said plasma production room wall may become 1.5 or more times of the amount of plasma loss in said reaction chamber wall.

[Claim 2] It is the operation of the plasma reactor which carries out anisotropic etching of the processed material which was equipped with the reaction chamber connected with the plasma production room, the waveguide which introduces microwave into said plasma production room, and the magnetic field generating means formed in the periphery of said plasma production room at said plasma production room, excited the electron cyclotron resonance by said microwave and the magnetic field by said magnetic field generating means, was made to generate the plasma, drew said plasma in said reaction chamber, and was installed in said reaction chamber, Operation of the plasma reactor characterized by making it possible to acquire the high etch selectivity stabilized in said anisotropic etching by setting up so that the amount of plasma loss in said plasma production room wall may become 2 double less or equal of the amount of plasma loss in said reaction chamber wall, and an anisotropy.

[Claim 3] A plasma production room and the waveguide which introduces microwave into said plasma production room, The reaction chamber connected with the magnetic field generating means formed in the periphery of said plasma production room at said plasma production room is prepared. By said microwave and the magnetic field by said magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the plasma treatment approach of the substrate which carries out anisotropic etching of said processed substrate by said plasma, supplying high-frequency power to the processed substrate which led said plasma to said reaction chamber, and was installed in said reaction chamber,

The plasma treatment approach of the substrate characterized by making it possible to acquire the high anisotropy stabilized in said anisotropic etching by setting up so that the amount of plasma loss in said plasma production room wall may become 1.5 or more times of the amount of plasma loss in said reaction chamber wall.

[Claim 4] A plasma production room and the waveguide which introduces microwave into said plasma production room, The reaction chamber connected with the magnetic field generating means formed in the periphery of said plasma production room at said plasma production room is prepared. It is the plasma treatment approach of the substrate which carries out anisotropic etching of the processed substrate which excited the electron cyclotron resonance, was made to generate the plasma, drew said plasma in said reaction chamber, and was installed in said reaction chamber by said microwave and the magnetic field by said magnetic field generating means, The plasma treatment approach of the substrate characterized by making it possible to acquire the high etch selectivity stabilized in said anisotropic etching by setting up so that the amount of plasma loss in said plasma production room wall may become 2 double less or equal of the amount of plasma loss in said reaction chamber wall, and an anisotropy.

[Procedure amendment 3]

[Document to be Amended] Specification

[Item(s) to be Amended] 0001

[Method of Amendment] Modification

[Proposed Amendment]

[0001]

[Industrial Application] This invention relates to improvement in the anisotropy in that anisotropic etching especially about the operation of a plasma reactor and the plasma treatment approach of a substrate of performing anisotropic etching of processed material, such as a semi-conductor substrate, using the plasma generated by electron cyclotron resonance (ECR) discharge.

[Procedure amendment 4]

[Document to be Amended] Specification

[Item(s) to be Amended] 0009

[Method of Amendment] Modification

[Proposed Amendment]

[0009] It is offering the operation of a plasma reactor and the plasma treatment approach of a substrate of one purpose of this invention enabling impression of the high bias voltage to processed material in view of the technical problem in such a conventional technique, and enabling stable etching which has a high anisotropy.

[Procedure amendment 5]

[Document to be Amended] Specification

[Item(s) to be Amended] 0010

[Method of Amendment] Modification

[Proposed Amendment]

[0010] Another purpose of this invention is offering the operation of a plasma reactor and the plasma treatment approach of a substrate of enabling etching of a high anisotropy by high etch selectivity, without impressing bias voltage to processed material.

[Procedure amendment 6]

[Document to be Amended] Specification

[Item(s) to be Amended] 0012

[Method of Amendment] Modification

[Proposed Amendment]

[0012] The operation of the plasma reactor by another mode of this invention A plasma production room and the waveguide which introduces microwave into the plasma production room, It has the reaction chamber connected

with the magnetic field generating means formed in the periphery of a plasma production room at the plasma production room. By microwave and the magnetic field by the magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the operation of the plasma reactor which carries out anisotropic etching of the processed material which drew the plasma in the reaction chamber and was installed in the reaction chamber by the plasma. By setting up so that the amount of plasma loss in a plasma production room wall may become 2 double less or equal of the amount of plasma loss in a reaction chamber wall, it makes it possible to acquire the high etch selectivity stabilized in anisotropic etching, and an anisotropy. The plasma treatment approach of the substrate according to another mode further of this invention A plasma production room and the waveguide which introduces microwave into the plasma production room, The reaction chamber connected with the magnetic field generating means formed in the periphery of a plasma production room at the plasma production room is prepared. By microwave and the magnetic field by the magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the plasma treatment approach of the substrate which carries out anisotropic etching of the processed substrate by the plasma while supplying high-frequency power to the processed substrate which drew the plasma in the reaction chamber and was installed in the reaction chamber. By setting up so that the amount of plasma loss in a plasma production room wall may become 1.5 or more times of the amount of plasma loss in a reaction chamber wall, it makes it possible to acquire the high anisotropy stabilized in anisotropic etching. The plasma treatment approach of the substrate according to another mode further of this invention A plasma production room and the waveguide which introduces microwave into the plasma production room, The reaction chamber connected with the magnetic field generating means formed in the periphery of a plasma production room at the plasma production room is prepared. By microwave and the magnetic field by the magnetic field generating means, excite a electron cyclotron resonance and the plasma is generated. It is the plasma treatment approach of the substrate which carries out anisotropic etching of the processed substrate which drew the plasma in the reaction chamber and was installed in the reaction chamber by the plasma. By setting up so that the amount of plasma loss in a plasma production room wall may become 2 double less or equal of the amount of plasma loss in a reaction chamber wall, it makes it possible to acquire the high etch selectivity stabilized in anisotropic etching, and an anisotropy.

[Procedure amendment 7]

[Document to be Amended] Specification

[Item(s) to be Amended] 0014

[Method of Amendment] Modification

[Proposed Amendment]

[0014] another voice of this invention – in the operation of the plasma reactor twisted like, since it is set up so that the amount of plasma loss in a plasma production room wall may become 2 double less or equal of the amount of plasma loss in a reaction chamber wall, the flow of the processed material upper plasma is not disturbed Therefore, by the plasma which carries out incidence with directivity into the reaction chamber in which processed material was installed, even if it does not impress bias voltage to processed material, etching of a high anisotropy may be performed. In this case, since the ion which carries out incidence has low energy compared with the case where bias voltage exists, etching which has the high selectivity depending on the quality of the material of processed material becomes possible at coincidence. In the plasma treatment approach of the substrate according to another mode further of this invention, since the amount of plasma loss in a plasma production room wall is set as 1.5 or more times of the amount of plasma loss in a reaction chamber wall, plasma potential is fixed in the processed substrate upper part. Therefore, since it has the operation whose bias voltage impressed to the processed substrate draws ion, without changing plasma potential even if it supplies high-frequency power to a processed substrate, it becomes possible to perform strong etching of an anisotropy. this invention – further – another voice – in the plasma treatment approach of the substrate twisted like, since it is set up so that the amount of plasma loss in a plasma production room wall may become 2 double less or equal of the amount of plasma loss in a reaction chamber wall, the flow of the processed substrate upper plasma is not disturbed Therefore, by the plasma which carries out incidence with directivity into the reaction chamber in which the processed substrate was installed, even if it does not impress bias voltage to a processed substrate, etching of a high anisotropy may be performed. In this case, since the ion which carries out incidence has low energy compared with the case where bias voltage exists, etching which has the high selectivity depending on the quality of the material of a processed substrate becomes possible at coincidence.

[Procedure amendment 8]

[Document to be Amended] Specification

[Item(s) to be Amended] 0028

[Method of Amendment] Modification

[Proposed Amendment] [0028] another voice of this invention -- in the operation of the plasma reactor twisted like, since the amount of plasma loss in a plasma production room wall is made into 2 double less or equal of the amount of plasma loss in a reaction chamber wall, without impressing high frequency bias power to processed material, it is possible to raise the etching anisotropy of processed material, and etching which has the high selection ratio which is dependent on the quality of the material of processed material with the plasma ion of low energy is attained. this invention -- further -- another voice -- in the plasma treatment approach of the substrate twisted like, since high frequency bias voltage is impressed to a processed substrate and the amount of plasma loss in a plasma production room wall is made into 1.5 or more times of the amount of plasma loss in a reaction chamber wall, the high-frequency power to a processed substrate can be efficiently impressed by homogeneity, and strong etching of an anisotropy may be realized. this invention -- further -- another voice -- in the plasma treatment approach of the substrate twisted like, since the amount of plasma loss in a plasma production room wall is made into 2 double less or equal of the amount of plasma loss in a reaction chamber wall, without impressing high frequency bias power to a processed substrate, it is possible to raise the etching anisotropy of a processed substrate, and etching which has the high selection ratio which is dependent on the quality of the material of a processed substrate with the plasma ion of low energy is attained.